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(54) Title: OPTICAL MICROPHONE CONSTRUCTION

(57) Abstract: An optical microphone device which comprises an inverted, cup-shaped body including a top wall and at least one side wall and being at least partly made of transparent material; at least two lenses projecting from the lower surface of said top wall and extending respectively towards said light source and said photodetector, and a pyramid-shaped air gap having a ridge separating said lenses.

OPTICAL MICROPHONE CONSTRUCTION

Field of the Invention

The present invention relates to optical microphones, more particularly, to optical microphones that may be constructed at low production and assembly costs.

Background of the Invention

Optical microphones are acoustical, pressure-sensitive devices, based on the sensing of light intensity changes resulting from the vibrations of an acoustic membrane. Such devices are disclosed, for example in U.S. Patents Nos. 5,771,091; 5,969, 838 and 6,091,497. One of the disadvantages of these microphones is their comparatively high cost, which resides in their being constructed of both electronic and optical elements, and the strict demand for specific high tolerances during their production.

Disclosure of the invention

It is therefore a broad object of the present invention to decrease the cost of optical microphones by providing an optical microphone structure consisting of two, separate, electronic and optical components, which structure does not require high tolerances during production.

It is a further object of the present invention to provide an optical component for the construction of optical microphones that is especially suitable for the mass production of mobile telephones and that enables the

building and testing of the entire electronic board, together with its optical component, before the final closing of the telephone housing.

A still further object of the present invention is to provide components for optical microphone construction that do not expose the microphone membrane to high temperatures during the process of soldering the electronic microphone elements onto the electronic board.

The invention therefore provides an optical microphone device, comprising an optical component, constituted by (a) an inverted, cup-shaped body including a top wall and at least one side wall and being at least partly made of transparent material; (b) at least two lenses projecting from the lower surface of said top wall and extending respectively towards said light source and said photodetector, and (c) a pyramid-shaped air gap having a ridge separating said lenses.

The invention further provides an optical microphone device, comprising interconnectable first and second components; said first component being an electronic component constituted by an electronic board carrying at least one light source and at least one photodetector spaced apart from each other and electrical contacts for said light source and said photodetector; and said second component being an optical component, constitute by (a) an inverted, cup-shaped body including a top wall and least one side wall and being at least partly made of transparent material; (b) at least two lenses project from the lower surface of said top wall and extending respectively towards said light source and said photodetector, and (c) a pyramid-shaped air gap having a ridge separating said lenses.

Brief Description of the Drawings

The invention will now be described in connection with certain preferred embodiments with reference to the following illustrative figures so that it may be more fully understood.

With specific reference now to the figures in detail, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of the preferred embodiments of the present invention only, and are presented in the cause of providing what is believed to be the most useful and readily understood description of the principles and conceptual aspects of the invention. In this regard, no attempt is made to show structural details of the invention in more detail than is necessary for a fundamental understanding of the invention, the description taken with the drawings making apparent to those skilled in the art how the several forms of the invention may be embodied in practice.

In the drawings:

Fig.1 is a cross-sectional view of an optical microphone in accordance with the present invention;

Fig. 2 is a top view of the microphone component shown at Fig. 1, with its membrane removed;

Fig. 3 is a cross-sectional view along line A-A of Fig. 2;

Fig. 4 is a bottom view of the microphone component of Fig. 1 with the electronic board removed;

Fig. 5 is a cross-sectional view of another embodiment of an optical microphone component according to the present invention;

Figs. 6 and 7 are cross-sectional and bottom views, respectively, of a further embodiment of an optical microphone component according to the present invention, and

Fig. 8 is a bottom view of a modification of the embodiment of Figs. 6 and 7.

Detailed Description of the Invention

Figs. 1 to 4 illustrate an optical microphone 2, consisting of two separate components 4 and 6. component 4 is the electronic portion of the microphone, while component 6 is the optical portion.

Electronic component 4 consists of an electronic board 8 having a light source 10 and a photodetector12, advantageously produced by through-hole technology. Also provided are electrical contacts 14, 16 of light source 10 and photodetector12, respectively.

The second, optical component 6 of microphone 2 is configured as an inverted, cup-shaped body having a top wall and a tubular side wall. The side wall of component 6 does not necessarily have to be tubular, but may instead be in the form of individual legs. Component 6 is microphone made of light-transparent material, and has two lenses 18, 20 projecting from its lower top surface 22 so as to concentrate light on an acoustically sensitive membrane 24 and to concentrate the light reflected from membrane 24 onto photodetector 12. A shallow recess 26 is formed on the upper surface 25 of the body, creating a space between the optical body and the membrane 24, which is mounted across the recess 26 by means of a ring 28. A pyramid-shaped air gap 30 within the component body separates the two lenses 18, 20 and , consequently separates the light beams that are directed and reflected from membrane 24 without exiting from the body. A ridge in air gap 30 creates a very narrow slot 32 at the apex of the pyramid. In addition, one or more small holes 34 are made to connect the air space below membrane 24 with the air gap 30, so as to substantially equalize the pressure on both sides of the membrane.

The electronic component 4 of the microphone may be produced as the entire electronic board of an electronic system incorporating the microphone, including a plurality of electronic devices as well as the components for the optical microphone.

For example, such an electronic system may be a mobile telephone and the electronic board 8 including the microphone electronic components may be a mobile telephone electronic board. Both of the microphone components are mounted and soldered by means of ordinary, *per se* known, mounting and soldering technology, together with the other electronic elements of the mobile telephone. The acoustically responsive membrane 24 is only then affixed onto component 6. Thus, membrane 24 is not exposed to damaging high temperatures during the process of soldering the electronic components onto the board of electronic component 4.

The above-described construction of the present invention provides a substantial advantage, since the presently known technology does not facilitate the mounting and soldering of a microphone element together with the other electronic elements of a telephone board. In the known technology, the mounting of the optical component of the microphone is then done manually after the mounting, soldering and tuning work is finished, even after the closing of the telephone housing (not shown).

Referring now to Fig. 5, there is illustrated a further embodiment of the invention, in which light source 10 and photodetector 12 are mounted on top of the upper surface of electronic board 36, advantageously by surface-mounting technology, and are not at least partially embedded therein, as shown in Fig. 1. In addition in the embodiment of Fig. 5, the lenses 18, 20 are oriented at a different angle with respect to the membrane 24, forming there between a smaller pyramidal air gap 30. A further difference in this embodiment resides in the manner of mounting membrane 24. Here, the optical component 6 is configured generally as an H-shape, forming two recesses on its upper portion; a shallow recess 26 and a recess 38 having a larger diameter, forming annular rim 40. The membrane 24 is placed across shallow recess 26 and is affixed in place by means of a cover 42 having apertures 44.

A further embodiment is depicted in Figs. 6-8, similar to that of Fig. 5 except for the lens configuration. In the embodiment of Figs. 6-8, a plurality of

lenses 46, 48, 50 is formed to transmit light from light source 10 to membrane 24 and to direct the light reflected from the membrane through three additional lenses 52, 54, 56 onto photodetector 12. The plurality of lenses assures the maximum utilization of the light, thus enhancing the sensitivity of the device. The small lenses 46 to 56 may be made in an ordinary, spherical form (Fig 7), or in the form of Fresnel rings, as shown in Fig. 8. In the latter case, it is possible to use several light sources and several photodetectors, disposed in a circle at the center of the optical component.

It will be evident to those skilled in the art that the invention is not limited to the details of the foregoing illustrated embodiment and that the present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof The present embodiment is therefore to be considered in all aspects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

WHAT IS CLAIMED IS:

1. An optical microphone device, comprising:

i) an inverted, cup-shaped body including a top wall and at least one side wall and being at least partly made of transparent material;

ii) at least two lenses projecting from the lower surface of said top wall and extending respectively towards said light source and said photodetector, and

iii) a pyramid-shaped air gap having a ridge separating said lenses.

2. An optical microphone device, comprising interconnectable first and second components;

said first component being an electronic component constituted by an electronic board carrying at least one light source and at least one photodetector spaced apart from each other and electrical contacts for said light source and said photodetector; and said second component being an optical component, constituted by:

i) an inverted, cupb-shaped body including a top wall and at least one side wall and being at least partly made of transparent material;

ii) at least two lenses projecting from the lower surface of said top wall and extending respectively towards said light source and said photodetector, and

iii) a pyramid-shaped air gap having a ridge separating said lenses.

3. The device as claimed in claims 1 and 2, further comprising a shallow recess on the upper surface of said top wall.

4. The device as claimed in claim 3, further comprising an acoustically responsive membrane mounted across said recess.

5. The device as claimed in claim 3, wherein said air gap is connected with said recess by at least one hole.

6. The device as claimed in claim 3, wherein said air gap communicates with the space in said recess below said membrane via a narrow slot formed by the ridge of said pyramid-shaped air gap.

7. The device as claimed in claim 1 or claim 2, wherein said optical component is provides with a plurality of spherical lenses.

8. The device as claimed in claim 1 or claim 2, wherein said optical component is provided with a plurality of circularly, concentrically disposed lenses.

9. The device as claimed in claim 1 or claim 2, wherein the side wall of said optical component is tubular.

10. The device as claimed in claim 3, further comprising a second recess in the upper surface of said top wall.

11. The device as claimed in claim 10, wherein said membrane is mounted across said shallow recess by means of an apertured cover fitted within said second recess.

12. An optical microphone device as claimed in claim 1 or claim 2, substantially as hereinbefore described and with reference to the accompanying drawings.

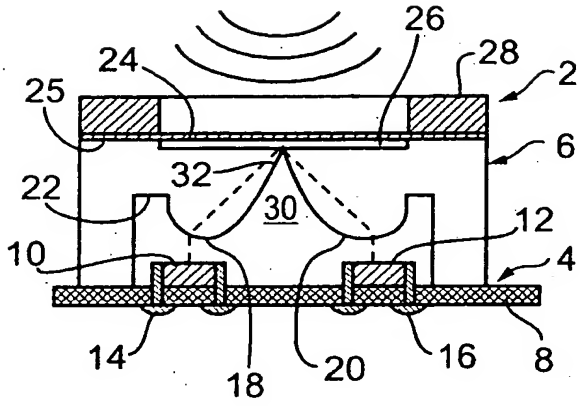

Fig. 1

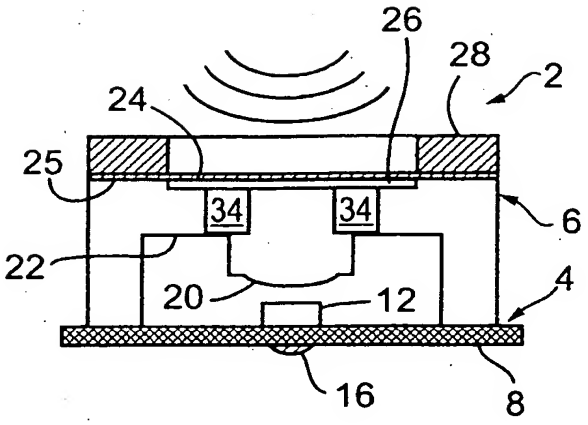

Fig. 3

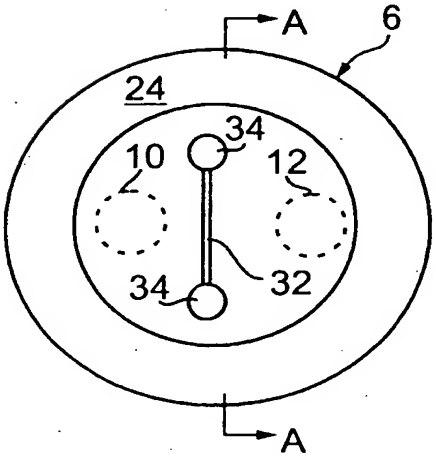

Fig. 2

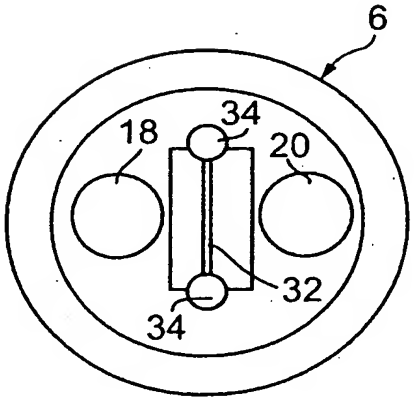

Fig. 4

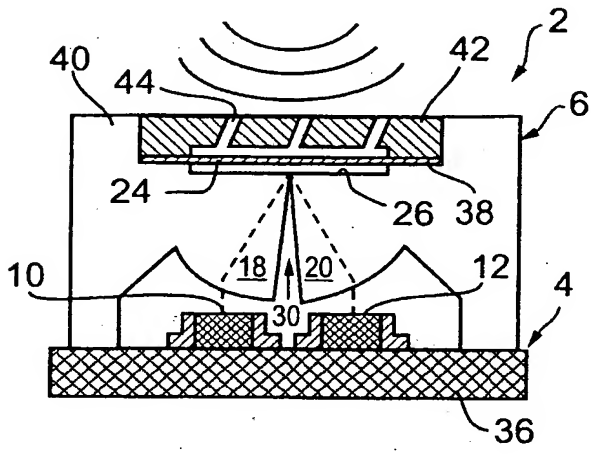

Fig. 5

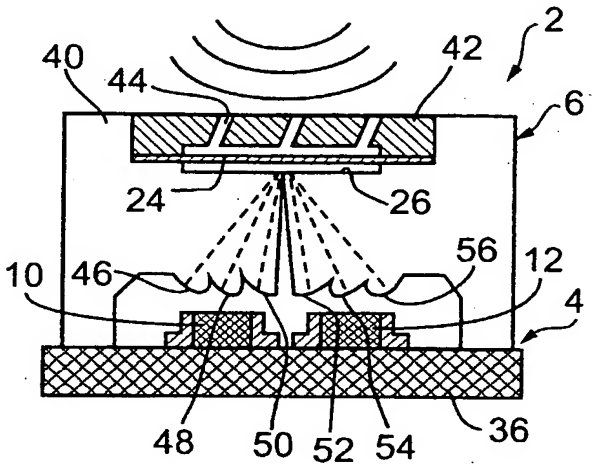

Fig. 6

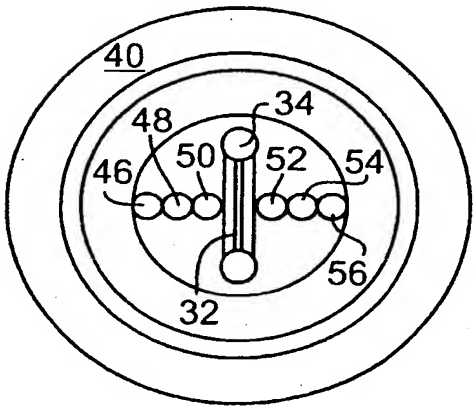

Fig. 7

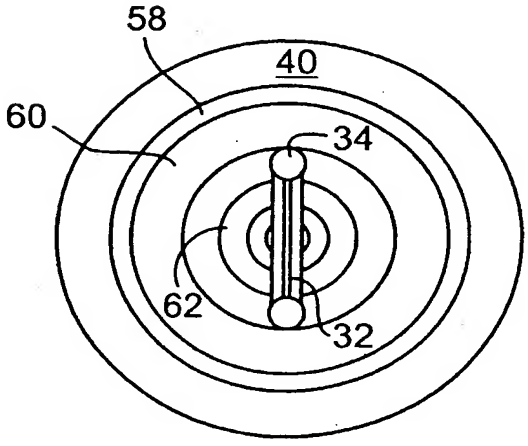

Fig. 8

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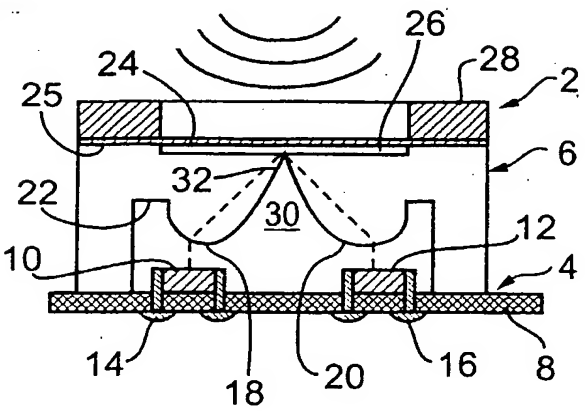
(54) Title: OPTICAL MICROPHONE CONSTRUCTION



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INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04R23/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2 335 108 A (SENNHEISER ELECTRONIC) 8 September 1999 (1999-09-08) abstract claims 1,2	1-12
A	US 5 333 205 A (BOGUT HENRY A ET AL) 26 July 1994 (1994-07-26) abstract column 2, line 3 - line 12	1-12
P,A	WO 01 28286 A (KOTS ALEXANDER ;PHONE OR LTD (IL); PARITSKY ALEXANDER (IL); KOBAYA) 19 April 2001 (2001-04-19) the whole document	1-12

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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Date of the actual completion of the international search	Date of mailing of the international search report
20 May 2003	27/05/2003

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Dionisi, M

INTERNATIONAL SEARCH REPORT

Information on patent family members

Intern[illegible] l Application No
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